Department Colloquium

Speaker: Maxime Theillard, University of California San Diego
Date: Friday January 20th, 2017
Time: 2:30 p.m.
Place: Jeffery 234
Title: High-fidelity simulations of complex fluid flows

Abstract: The remarkable properties of complex fluids are the consequence of a subtle interplay between multiple physics, occurring on different length and time scales and often involving deformable interfaces. Numerically, all these characteristics make these flows extremely challenging to simulate. The numerical approach I will present in this talk is built on an incompressible fluid solver using adaptive Octree/Quadtree grids, which are highly effective in capturing disparate length scales. Designed as a stable projection method where viscous effects are treated implicitly, our solver was shown to be unconditionally stable. First, I will show how the method can be extended to simulate non-miscible two-phase flows. In this novel approach, the interface and continuity equations are treated in a sharp manner and by using a modified pressure correction projection method we were able to alleviate the standard time step restriction incurred by capillary forces. These properties make our framework a robust tool to simulate challenging single- and two-phase flow problems. Second, I will focus on another type of complex fluids: confined active suspensions, of which a bath of swimming microorganisms is a paradigmatic example. I will detail how our simulation engine was used to model such flows and present some numerical examples. Specifically I will show how collective behavior and spontaneous flowing states can emerge from hydrodynamics interactions between swimmers and analyze the influence of the confining geometry has on these dynamics.